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XXIV. *On the Construction and Arrangement of the Berlin Astronomical Ephemeris for 1831.* By Professor ENCKE*.

THE construction of the Ephemeris for this year is the same as that for the preceding one, with the exception that some columns have been added to those relating to the positions of the planets, and to the occultations of stars. With a view to prevent all misunderstanding in regard to the times of rising and setting of the sun and moon, and of the changes of the moon, I distinctly remark that, with the exception of solar eclipses, the times given never refer to *apparent time*, but are always meant for *mean solar time*.

The comparison of the end of the last with the beginning of the present Ephemeris, has led to the discovery of differences, fortunately of no moment, which had arisen from error, and from neglecting small quantities.

In the calculation of the Ephemeris of the sun both for the last and for the present year, the tables of Professor Bessel, published, subsequently to the calculation, in Professor Schumacher's *Nachrichten*, could not be applied. Having however derived, from the corrections which had been published, the elements on which they were founded, I constructed from the same the necessary tables, and thus the difference is of any consequence in one column only. In order to obtain a rigorous agreement with Professor Bessel's tables, it will be necessary to increase the mean right ascension of the sun, or the sidereal time at the mean noon, given in the Ephemerides for the two years, throughout, by $+0^{\text{h}}06$. This correction is constant through the whole year, because the smaller corrections dependent on the two nutations are exactly the same in Bessel's and in my tables.

In the calculations for the positions of the moon, my aim has again been to be accurate to $\pm 0^{\text{h}}5$; yet there are places where the differences appear to indicate the necessity of corrections greater than this quantity. A revisal of the calculations having, however, not shown any error, the data have been given without alteration. The columns of the place of the moon at the two culminations have in the present Ephemeris been calculated more accurately, and each datum has been found directly without interpolation. Although the excellent method of Professor Bessel of predicting occultations of stars, which, with his permission, I have reprinted in this Ephemeris†, will perhaps supersede the use of the lower culminations here given; yet I did not think it proper to leave them out, as they were necessary to me for the calculation of occultations of

* Translated from the original German.

† See Phil. Mag. and Annals, Nov. and Dec. 1829.

stars,

stars, and as they may, perhaps, still be used for observations of the moon in general.

I have now availed myself, in the calculations for Mercury, of the corrections of Lindenau's tables, which Prof. Schumacher had already published some time since. I deem it not superfluous again to observe, that the examination of the places calculated for every second day by their differences, is not sufficient to discover all possible errors of the calculation.

There is an error of $10''$ in the heliocentric place of Venus on the 31st of December in the preceding Ephemeris, caused by an error in the calculation, which extends likewise to the geocentric place; this error has however no influence on the data for other days, as the place on that day had been calculated directly and could not be examined by differences.

Mr. Hansen has kindly informed me that the longitude of the node of Venus, used in the calculations for this year and the preceding one, differs from the value assigned to it in Lindenau's tables. I have thought proper to make an alteration in this element, because the value derived for 1808, in the preface of the tables, from the latest epoch, is smaller by $1' 15''$ than the value afterwards adopted. The calculation is founded on the epoch of 1750, and from that date forward an annual motion of $31''.2$ has been applied, contrary to what the author himself declares to have been formerly adopted. As the calculations of the transits of Venus likewise give a smaller longitude of the node, and a motion of the node smaller than $31''.2$, I have thought that I might assume the longitude of the node of Venus $\Omega = 74^\circ 33' 48'' + 30.66(t - 1765)$.

Hence we have for 1808, $\Omega = 74^\circ 55' 46''$; while, according to the preface, the observations have given $\Omega = 74^\circ 56' 37''$; and the tables have $\Omega = 74^\circ 57' 52''$. The values adopted by me give therefore a result more nearly approximating to the latest observations, than that of the tables, and agree at the same time with those transits which must give the longitude of the node with greater accuracy than any other observation. If, however, later observations should prove the longitude of the tables to be more accurate, I shall adopt their values in future.

Of all heavenly bodies whose places were given in the last Ephemeris, Ceres was the one whose places were likely to deviate most from the truth. For the present year, I have therefore derived new elements from the last oppositions, taking into calculation the perturbations of Jupiter only, respecting which a more detailed explanation will be found below*. Although it cannot be expected that these preliminary determinations will very accurately represent the places of Ceres, yet they will give

* To be given in a future Number of the Phil. Mag. & Annals.

them

them with sufficient accuracy to enable observers to find Ceres with certainty, even among small stars, as the error will probably always fall short of a minute in arc. For the Ephemeris of the preceding year, published in the former volume, I beg therefore to substitute the following, calculated for 1830, by the latest elements.

CERES 1830.					
<i>Ephemeris for the Opposition.</i>					
12 ^h Mean Time.	Geoc. Rt. Ascen.		Geoc. Declin.	Log. Distance.	
	♂		♀	♀ from ♂	♀ from ☉
April	14	14 ^h 57' 40" 25	—4° 39' 9" 0	0.23566	0.42772
	15	56 54.41	36 51.0	0.23473	
	16	56 7.60	34 35.3	0.23387	
	17	55 19.88	32 22.3	0.23307	
	18	54 31.28	30 12.3	0.23234	0.42820
	19	53 41.86	28 5.5	0.23167	
	20	52 51.67	26 2.2	0.23106	
	21	52 0.79	24 2.6	0.23052	
	22	51 9.26	22 7.0	0.23005	0.42869
	23	50 17.14	20 15.7	0.22965	
	24	14 49 24.49	—4 18 28.8	0.22931	
	25	48 31.38	16 46.7	0.22905	
	26	47 37.88	15 9.5	0.22885	0.42919
	27	46 44.05	13 37.7	0.22873	
	28	45 49.94	12 11.3	0.22867	
	29	44 55.62	10 50.5	0.22868	
♂ May	30	44 1.16	9 35.6	0.22876	0.42968
	1	43 6.62	8 26.8	0.22891	
	2	42 12.05	7 24.3	0.22913	
	3	41 17.52	6 28.2	0.22942	
	4	14 40 23.09	—4 5 38.7	0.22978	0.43018
	5	39 28.82	4 56.0	0.23021	
	6	38 34.76	4 20.3	0.23071	
	7	37 40.98	3 51.6	0.23127	
	8	36 47.52	3 30.1	0.23190	0.43067
	9	35 54.46	3 16.0	0.23260	
	10	35 1.83	3 9.3	0.23336	
	11	34 9.70	3 10.2	0.23418	
	12	33 18.11	3 18.7	0.23507	0.43117
	13	32 27.13	3 35.1	0.23602	
	14	14 31 36.80	—4 3 59.4	0.23704	
	15	30 47.17	4 31.6	0.23812	
	16	29 58.30	5 11.7	0.23926	0.43167

The manner in which the perturbations of the small planets are calculated,—viz. by applying the corrections to the elements themselves, and not to the places calculated by the mean elements,—renders a generally true exhibition of their orbits impossible, and the data given in astronomical books neither refer to mean elements generally, nor even to variable elements taken for a certain moment of time. As however for all the four new planets, the effect of Jupiter at least, although perhaps not on the same hypothesis of its mass, has been applied, it may perhaps be interesting to exhibit the form of the four orbits for the same moment of time. The following elements of Pallas, Juno, and Vesta, refer to the moment of the opposition of Pallas; those of Ceres properly for the moment of her opposition. The distance being however small, the change of the latter, in order to reduce them accurately to the moment to which the others belong, would be very small.

Elements of the small Planets.

Epoch of the mean longitude 1831. July 23.

0^h mean Time of Berlin.

Vesta.

Mean longitude	84° 47' 3 ^h .2
Mean anomaly.....	195 35 26 .2
Longitude of the perihelion	249 11 37 .0
Longitude of the node	103 20 28 .0
Inclination	7 7 57 .3
Angle of eccentricity	5 .4 50 .8
Mean daily sidereal motion.....	977.75540
Log. of the semi-axis major.....	0.373185

Juno.

Mean longitude	74° 39' 43 ^h .6
Mean anomaly.....	20 22 30 .9
Longitude of the perihelion	54 17 12 .7
Longitude of the node.....	170 52 34 .5
Inclination	13 2 10 .0
Angle of eccentricity	14 48 24 .2
Mean daily sidereal motion.....	813.52533
Log. of the semi-axis major	0.426424

Pallas.

Mean longitude	290° 38' 11 ^h .8
Mean anomaly ..	169 33 11 .3
Longitude of the perihelion.....	121 5 0 .5
Longitude of the node.....	172 38 29 .8
Inclination	34 35 49 .1
Angle of eccentricity ..	14 0 16 .3
Mean daily sidereal motion.....	768.54421
Log. of the semi-axis major	0.442892

Ceres.

Ceres.

Mean longitude	307° 3' 25".6
Mean anomaly	159 22 2.1
Longitude of the perihelion	147 41 23.5
Longitude of the node.....	80 53 49.7
Inclination	10 36 55.7
Angle of eccentricity	4 24 3.9
Mean daily sidereal motion	769.26059
Log. of the semi-axis major	0.442622

With these elements the places of the planets may be determined almost the whole year to a few minutes. If the planets were to be arranged by the length of the great axis, Pallas and Ceres ought properly to exchange places. As, however, by this manner of applying the perturbations, Ceres may and will have at times, in consequence of the periodical changes of the great axis, a greater mean distance, it will not be necessary to deviate from the arrangement usually followed.

With regard to Jupiter and Saturn, it had been overlooked, when preparing the preceding volume, that the data of the tables of epochs were to be corrected, on account of the inequality of the precession. Without regarding the changes of the longitudes of the perihelion and of the node, as well as the greatest equation of the centre, all which will have but an exceedingly small influence, the heliocentric longitudes of Jupiter and Saturn, as given for the year 1830, must, for the reason above assigned, be augmented throughout by 2".2 decimal seconds, or 0".7 sexagesimal seconds. The influence of this correction on the geocentric places will not be of any consequence for the declinations of the two planets, as it may be assumed with sufficient accuracy $= 0".3 \cdot \frac{r \cos \delta}{\Delta} \cos \lambda$, where r

and λ designate the heliocentric distance and longitude, Δ and δ the geocentric distance and declination. In like manner, the principal part of the influence of the geocentric right ascension may be applied by increasing the right ascensions in time by 0".05.

The ratio of the axes of the orbits of all the satellites of Jupiter, given in the preceding volume, deviates considerably from the truth. This ratio was obtained by the reduction of the positions of the orbits of the satellites to the ecliptic, for which purpose Gauss's formulæ were applied. In calculating them, however, it was overlooked, that these formulæ do not give the inclination itself, but only one half of it; so that the ratio of the axes given in the preceding year's Ephemeris refers to an inclination of the orbits, which is only one half of what it ought to be. This error may for the greatest part be remedied by substituting for the given

given divisor $\frac{a}{b}$ throughout one half of it. The sign remains unchanged. These columns being of less importance, and as, although incorrect, they truly indicate the position of the satellite with respect to the great axis, I have not deemed it necessary to give here the corrected values.

The calculations of the path of the moon have again been divided between Messrs. Herter, Wolfers, and Dannemann. Science has lost the services of the latter gentleman by a sudden and premature death, shortly after he had finished his share of these calculations, when on the point of undertaking a situation at the public school at Lingen.

Mr. Herter has, besides, had the kindness to undertake the calculations for Mercury; while Mr. Wolfers has completely calculated the paths of Venus, of Jupiter, and of Saturn, and the occultations of Jupiter's satellites.

The apparent places of Maskelyne's thirty-six principal stars will have, in this year's *Ephemeris*, an unequalled degree of accuracy, as Prof. Bessel, at my request, has had the kindness to have them calculated by one of his pupils, agreeably to his latest investigations. The comparison of the calculations of 1830, which has been added, proved that, with the exception of α Aquilæ, no alterations would have been required in the right ascensions. For this star the correction is for Jan. 0... $-0''.012$.

The differences in the declinations do not exceed $\pm 0''.02$, with the exception of α Orionis, whose declinations are to be thus corrected.

+ $7^{\circ} 21'$

52.76	81	49.61	26	57.12	104	60.59	73
51.95	70	49.87	37	58.16	97	59.86	85
51.25	59	50.24	50	59.13	87	59.01	95
50.66	48	50.74	62	60.00	71	58.06	97
50.18	35	51.36	73	60.71	53	57.09	97
49.83	25	52.09	84	61.24	31	56.12	97
49.58	14	52.93	94	61.55	10	55.20	92
49.44	4	53.87	112	61.65	14	54.37	83
49.40	4	54.99	106	61.51	35		
49.44	17	56.05	107	61.16	57		

These differences, which never exceed $0''.2$, were caused by an error in the reduction to 1830.

There is besides a difference of $0''.12$ for the declination of γ Aquilæ for Jan. 0, by which quantity the value given is too small.

The other nine stars will, indeed, not have the same accuracy, either as to the original mean position, or as to the
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manner of calculating the reductions. Neither can it be denied that for well-furnished observatories too great a number of principal stars is unnecessary and a waste of time. I have, however, believed, that I ought not to swerve from the example of Professor Schumacher. For observatories which have not the advantage of a perfectly firm position of their instruments, a greater number of northern stars, which may be observed both above and below the pole, may be of advantage in many cases, even if the rigorous determination may be better derived from the thirty-six principal stars. Some differences, imperceptible in practice in the mean places, compared with the data of the preceding year, arise from a new derivation of the same.

New tables of δ Ursæ Minoris, which we are to expect from Professor Bessel, could not yet be made available for the present year. A comparison of these tables with the data for 1830 and 1831, has proved that the following corrections are to be applied to the date of the Ephemeris with respect to this star.

<i>δ Ursæ Minoris.</i>				
Date.	1830.		1831.	
	Right Ascen ⁿ .	Declination.	Right Ascen ⁿ .	Declination.
January 0	+0 ^{''} 48	+0 ^{''} 26	+0 ^{''} 57	0 ^{''} 20
April 10	+0 ^{''} 56	+0 ^{''} 20	+0 ^{''} 61	0 ^{''} 25
July 19	+0 ^{''} 64	+0 ^{''} 23	+0 ^{''} 58	0 ^{''} 24
October 27	+0 ^{''} 60	+0 ^{''} 23	+0 ^{''} 64	0 ^{''} 24

Applying therefore, in both Ephemerides throughout, these corrections,—

Right ascension..... +0^{''}60 (time)

Declination +0^{''}24 (arc),

we shall have nearly such an approximation to the latest determinations, as a rigorous calculation by them would have admitted.

Agreeably to the wish of some of the astronomers who use this Ephemeris, I have given the conjunction of the planets Mercury, Venus, Mars, Jupiter and Saturn, with the moon and with each other, in every case in right ascension, for every month, even when no occultation will take place. For the four new planets the intensity of light in their opposition has been given agreeably to Professor Bessel's idea; viz. that the intensity of light which the planet would have when equidistant

distant from the sun and the earth, and at a distance equal to its mean one, or to its semi-axis major, should be taken as unity. For the purpose of determining the longitude, the stars which are on the parallel of the moon at the time of the moon's transit over the meridian, have again been selected. Agreeably to the wish of Professor Argelander, the horary motion of the moon in right ascension has always been added, in order to facilitate to observers in other places the exact calculation of the transit. The given horary motion of the moon in right ascension, being multiplied by the difference of longitude from Berlin, expressed in parts of an hour, taken negatively if east, and the product being applied to the given right ascension, the time of transit will be obtained with perfect exactness, as the given horary motion is that belonging to a lunar hour. The declination which is added has already for the greater part been divested of the influence of parallax, at least for Berlin, and may serve in our northern countries, without any further correction, for pointing the instruments. It may perhaps be doubtful whether, for observations of the moon's second limb in the early hours of the morning, the addition of stars would be of essential service, as they must often, for having the necessary light, be at a considerable distance from the parallel of the moon. Considering the accuracy of the principal stars, it appears that the derivation of the right ascension of the moon's second limb from all principal stars, and the position of the instrument, would lead to results quite as accurate as would be obtained by the observed difference in right ascension, of stars which are at considerable distances from the parallel of the moon.

The arrangement with regard to occultations of stars is sufficiently explained by the paper on that subject (*Phil. Mag.* for Nov. and Dec. 1829). The size of the page did not permit me to add at once the declination of the stars, which is to be taken from the list of occulted stars immediately following. The calculation was made twice, in order to ensure exactness: First, by the method explained in the preceding year's volume, which, especially for several occultations on the same day, facilitates the decision as to their taking place, or not. Next, a moment of time was chosen, which was as near the time of the smallest distance, and as convenient for interpolation, as possible; and for this moment the values of p, q, p', q' were calculated, and thence the immersions and emersions were deduced. The year 1831 is distinguished by many considerable occultations. Aldebaran will be occulted six times, Regulus twice, and, besides, Jupiter and Saturn once.

Although the tables next following will no more serve the
2 A 2 purpose

purpose for which they were intended in the preceding volume, as the quantities p, q, p', q' give now the relative position of the moon to the stars and the motion of the former, they have, notwithstanding, been added, in order to facilitate the calculation of the occultations of such stars as are not given in our list.

Both my own comparison and the communications of others have brought to my knowledge a greater number of misprints than ought to exist in such a volume. Most of them, or almost all, do not arise from a want of attention in the printing-office, which has perfectly fulfilled every expectation, but from the unavoidable transferring and copying of the columns. It would hardly be worth while to enumerate them, as by the regularity of the differences every considerable error will be easily detected at first sight. I beg, however, to add this one remark—that, as in the case of logarithmic tables one acquires the habit, when taking out a number, always to cast one's eye on the preceding and following number, so, in the use of this book, the small trouble of slightly looking at the numbers close to the one wanted, ought not be dispensed with. For accurate calculations it is besides always necessary to form several orders of differences.

XXV. *On Artificial and Natural Arrangements of Plants: and particularly on the Systems of Linnæus and Jussieu.* By WILLIAM ROSCOE, Esq. F.L.S.

[Concluded from page 104.]

ACCORDING to each of these systems, the classes are divided into orders. Linnæus, still aiming at simplicity, but founding his decisions on strong natural distinctions, has for this purpose recourse to the pistillum, or style, the immediate organ of impregnation, and essential to the formation of the fruit. As a single word has expressed the class, so another word now gives us the order; and to a practical botanist the expression *Pentandria monogynia* suggests the idea of a division of plants including, among many others, the natural order of *asperifoliæ*; as that of *Pentandria digynia* does of the *umbelliferæ*. The difficulties under which Jussieu labours now become apparent. He has indeed formed the vegetable kingdom into fifteen classes; under which heads he has arranged one hundred tribes or orders, each consisting of various families of plants supposed to be allied to each other; but when we ask for the distinctions of these orders, or, in other words, by what peculiarities they are to be recognised, and